

# Evaluations on Innovation Capability and its Influence on Industry

## Performance of Aerospace Industry

Min-hui Tong<sup>1,a</sup>,

<sup>1</sup>Management and Economics School, Jingdezhen Ceramic Institute, Jingdezhen 333403, China.

<sup>a</sup>Tongminhuicom@163.com

**Keywords:** Innovation Capability, Aerospace Industry, Industry Performance

**Abstract:** Innovation Capability is key performance element of strategic emerging industry. This paper analyzes innovation capability of aerospace industry based on breaking innovation capability down to R&D activity, innovation input, innovation environment and innovation output, the results manifest that Tianjin, Shaanxi, Jiangsu, Sichuan and Guangdong have high industry performance due to high innovation capability. Then analyzes influence of innovation capability of aerospace industry to industry performance of 21 provinces (cities) by unary linear regression respectively, which manifest innovation capability of aerospace industry develops unbalanced among different areas, its role is negative and should be improved in the future.

### Introduction

Reality development manifests that China has entered into a state of sub-high growth whose growth rate is 6.9%, 6.7% and 6.9% at year 2015, 2016 and 2017. Although many scholars remain optimistic, consensus is China is passing into “new normal” economy. President Xi elaborated characteristics of “new normal” firstly at APEC at year 2014, which are medium-to-high speed of growth, upgrading economy structure and innovation-driven impetus. Therefore, innovation is a new engine to promote development under “new normal” circumstance, which is more important in developing aerospace industry which is both strategic emerging industry and high-tech industry. Overall, this paper aims to accelerate development by analyzing its innovation capability and industry performance and its relationship and explicating key factors of performance.

### 1 Data Processing of Industry performance and Innovation Capability of Aerospace Industry

**1.1 Index selection and data source.** According to “2016 China Statistic Yearbook on High Technology Industry”, this paper chooses production and management condition as industry performance ( $Y$ , dependent variable), R&D activity ( $X_1$ ), innovation input ( $X_2$ ), innovation environment ( $X_3$ ) and innovation output ( $X_4$ ) as innovation capability (independent variable) (see Table1). Because of data missing, study objects are 21 provinces, few data replaced by previous data and its value added by industry GDP index.

Table 1 Industry performance and innovation capability evaluation index system

Independent Variable		Dependent Variable
R&D Activity ( $X_1$ )	NO. R&D Enterprises (unit, $X_{11}$ )	Capital Assets (billion, $Y_1$ )
	R&D Personnel (person, $X_{12}$ )	
	Full-time Equivalent of R&D Personnel (man-year, $X_{13}$ )	
	Intramural Expenditure on R&D (1000 yuan, $X_{14}$ )	
	Expenditure on New Products Development (1000 yuan, $X_{15}$ )	
Innovation Input ( $X_2$ )	Annual average NO. of Employed Personnel (10,0000 persons, $X_{21}$ )	Revenue from Principal Business (100 million yuan, $Y_2$ )
	NO. of Projects Completed and Put into Use(unite, $X_{22}$ )	
	Investment (100 million yuan, $X_{23}$ )	
	Newly Increased Fixed Assets (100 million yuan, $X_{24}$ )	
Innovation Environment ( $X_3$ )	NO. of Enterprises Having R&D Activities (unit, $X_{31}$ )	Profits (100 million yuan, $Y_3$ )
	R&D Institutions (unit, $X_{32}$ )	
	Personnel in R&D Institutions (person, $X_{33}$ )	
	Expenditure in R&D Institutions (100 million yuan, $X_{34}$ )	
Innovation Output ( $X_4$ )	New Products (item, $X_{41}$ )	Export (100 million yuan, $Y_4$ )
	Sales Revenue of New Products (1000 yuan, $X_{42}$ )	
	Patent Applications (piece, $X_{43}$ )	
	NO. of Patents in Force (piece, $X_{44}$ )	

**1.2 Data processing of Principal Component Analysis(PCA).** Because of strong correlativity, it is essential to do PCA to reduce discrepancy resulting from multicollinearity by software STATA. Firstly, data standardization. Employing standard deviation standardization to wiping off unit limitation. Secondly, correlation analysis. Strong correlation is existing between different variables referring to  $Y_1$  and  $Y_2$ ,  $X_{12}$  and  $X_{13}$ ,  $X_{14}$ ,  $X_{15}$ ,  $X_{14}$  and  $X_{15}$ ,  $X_{31}$  and  $X_{31}$ , which mean information overlap. Lastly, do PCA (see table 2). Analysis results that variance contribution is greater than 65% and only 1 initial eigenvalues is exceeding 1 which manifest PCA is good. Therefore, dependent variables are reduced to 4 and independent variables are reduced to 1 which will do unary linear regression later.

Table 2 PCA results

Index	Eigenvalues	Variance Contribution	PCA Formula
$Y$	2.879	71.97	$Y = 0.5574y_1 + 0.5811y_2 + 0.5529y_3 + 0.2143y_4$
$X_1$	4.352	87.03	$X_1 = 0.3601x_{11} + 0.4689 + 0.4665x_{23} + 0.4644x_{14} + 0.4660x_{15}$
$X_2$	2.969	74.22	$X_2 = 0.4256x_{21} + 0.5010x_{22} + 0.5552x_{23} + 0.5096x_{24}$
$X_3$	3.100	77.49	$X_3 = 0.5060x_{31} + 0.5254x_{32} + 0.4890x_{33} + 0.4784x_{34}$
$X_4$	2.515	62.88	$X_4 = 0.5522x_{41} + 0.4431x_{42} + 0.4300x_{43} + 0.5602x_{44}$

## 2. Analysis on Aerospace Industry Performance and its Innovation Capability

**2.1 General overview.** Computing PCA scores by PCA formula above manifests ranking of different provinces (see table 3). As shown by calculations, innovation inputs (independent variables) have consistency with industry performance (dependent variable), however, there are several exceptions including Tianjin, whose innovation inputs are low but outputs are incredible high. Provinces of high industry performance contain Tianjin, Shaanxi, Jiangsu, Sichuan, Guangdong, low performance include Chongqing, Zhejiang, Heilongjiang and Jiangxi; provinces of abundant R&D activity include Shaanxi, Beijing and Sichuan, on the contrary Chongqing, Shanxi,

Fujian and Anhui are scarce; provinces of high innovation input include Shaanxi, Sichuan and Jiangsu, oppositely Shanxi, Heilongjiang, Fujian and Chongqing are low; provinces of good innovation environment are Shaanxi, Jiangsu, Liaoning, Guizhou and Sichuan, inversely Shanxi and Chongqing are awful; province of productive innovation output is Shaanxi while Shanxi, Chongqing, Fujian and Anhui is low yield. In general, index ranking has no relation with regional development because aerospace industry is typical defense industry whose development depends on national industrial distribution policy and support strength to a great extent.

**2.2 Well-Developed Provinces Analysis.** Data analysis indicates that aerospace industry performance of Tianjin, Shaanxi, Jiangsu, Sichuan and Guangdong is well, whose innovation inputs including R&D activity, innovation input, innovation environment and innovation output are also great synchronously except Tianjin city. The main reasons principally lie in governmental co-ordination, optimized industrial pattern and abundant research institutions: government pay attention to introduce important projects including Airbus (Tianjin) final assembly line, Air China helicopter Tianjin industrial base, Spaceflight Shenzhou aircraft Co., Ltd. industrial base (UAV, unmanned aerial vehicle), etc.; Tianjin has formed “3 planes, 1 rocket, 1 satellite and 1 station ” industrial pattern that large aircraft, helicopter, UAV, large rocket, satellite and space station are representative products; plenty of higher research institutions including China Academy of Launch Vehicle Technology, China Academy of Space Technology, China institute of aerodynamic technology, etc. have established a number of research & development test sites in Tianjin.

Table 3 PCA calculations of all provinces

Provinces	$Y$	$X_1$	$X_2$	$X_3$	$X_4$
Beijing	0.650	1.674	0.242	0.463	1.689
Tianjin	5.201	-0.169	-0.199	-1.405	1.141
Hebei	-1.041	-1.177	0.111	-0.958	-1.443
Shanxi	-1.278	-1.798	-1.698	-1.667	-1.737
Liaoning	0.369	0.639	-0.884	1.827	1.900
Heilongjiang	-1.373	0.853	-1.532	-0.498	0.169
Shanghai	0.096	0.603	-0.950	-0.503	-0.516
Jiangsu	1.255	0.645	2.878	3.635	1.009
Zhejiang	-1.398	-1.449	-1.088	-1.381	-1.461
Anhui	-1.288	-1.631	-0.965	-1.306	-1.618
Jiangxi	-1.347	-1.437	0.645	-0.915	-1.007
Fujian	-0.136	-1.748	-1.354	-1.031	-1.648
Shandong	-1.250	-1.261	-0.397	-1.198	-1.197
Henan	-0.464	-0.250	0.231	0.286	-0.021
Hubei	-0.765	-0.672	-0.483	-0.900	-0.721
Hunan	-0.895	-0.529	-0.353	-1.160	-0.944
Guangdong	1.023	-0.273	-0.481	0.714	1.353
Chongqing	-1.404	-1.799	-1.460	-1.659	-1.688
Sichuan	1.120	1.080	3.264	1.396	1.124
Guizhou	-0.335	0.954	-0.603	1.539	1.565
Shaanxi	3.259	7.747	5.075	4.722	4.051

### 3 Innovation Capability Influence on Industry Performance of Aerospace Industry

This paper does unary linear regression with dependent variable  $Y$  and independent variables  $X_1$ ,  $X_2$ ,  $X_3$  and  $X_4$  to find innovation capability influence on industry performance of aerospace

industry based on calculations of table 3. Do correlation analysis firstly which manifests it is feasible to do regression because variables have strong positive correlation. Results shown in table 4 is credible,  $Y$  and  $X_1$ ,  $X_2$ ,  $X_3$  and  $X_4$  has higher positive correlation;  $R^2$  have certain explanatory power whose value is between 0.226-0.645;  $P$  value is significant, too.

In general, R&D activity, innovation input, innovation environment and innovation output have different influence on industry performance of aerospace industry at year 2016, that is innovation output clearly have greatest influence whose patents or new products can be transformed into profitable commodities quickly; R&D activity, innovation input and innovation environment should do not play its due role, R&D activity is high risk, innovation input is scale economy and innovation environment is hysteretic which have put an enormous hindrance to the function it should have.

Regression results manifest that when innovation capability of R&D activity, innovation input, innovation environment and innovation output marginal contribution to industry performance is 0.471, 0.532, 0.477 and 0.770 respectively, all data are less than 1 mean innovation capability does not paly positive role on industry performance. Meanwhile, this result is much less than role of R&D activity, new product development &production, patent and technology acquisition &transformation on industry performance are 1.207, 1.154, 1.329 and 1.285. Therefore, as a strategic emerging industry and high-tech industry, aerospace industry is unmatched position with its function.

Table 4 Regression of innovation capability and aerospace industry performance

Dependent variable	Independent variable	Coefficient	Constant	$R^2$	P Value
$Y$	$X_1$	0.471	-0.000	0.337	0.006***
	$X_2$	0.532	-0.000	0.293	0.011**
	$X_3$	0.477	-0.000	0.246	0.022**
	$X_4$	0.770	-0.000	0.520	0.000***

#### 4 Conclusion and Suggestion

Innovation capability is important to industry development under background of “new normal” economy, so is to aerospace industry. This paper quantitative calculates marginal contribution of R&D activity, innovation input, innovation environment and innovation output to industry performance is 0.471, 0.532, 0.477 and 0.770 respectively based on industry performance and innovation capability evaluation index system by PCA, which indicates aerospace industry should be further developed and innovation capability should be well formed. Specifically, every province should develop aerospace industry by its practical condition, laggard provinces including Chongqing, Zhejiang, Heilongjiang, Jiangxi, Anhui, Shanxi, Shandong and Hebei should learn from advanced provinces; advanced provinces including Tianjin, Shaanxi, Jiangsu, Sichuan and Guangdong should keep present priority and learn from developed countries; midstream provinces including Hunan, Hubei, Henan, Guizhou, Fujian, shanghai, Liaoning and Beijing should intensify capability of fundamental research and applied research.

#### References

- [1] Wenyong Zhou, Yang Xiang. An empirical study on key factors of regional innovative capability about China’s provinces and cities, Science Research Management, S1 (2015) 29-35.
- [2] Yu Zhang. Tianjin aerospace industry increase 56.5 times in 5 years whose scale is leading the country, Gui Gu, 15 (2013).

- [3] yuefeng ma, jianzhong li. Empirical studies of the innovation capability to performance impacts measuring of the high-tech industry, scientific management research, 5 (2014) 63-66.
- [4] Zhengzhi Zhang, Yimei Xie, Wenqiang Zhang. Analysis on the path of enhancing industrial innovation capability of chinese aerospace & aviation industry, Science and Technology Management Research, 5 (2011) 7-10.